Fisheries and Oceans Canada | Pêches et Océans Canada
Ecosystems and Oceans Science | Sciences des écosystèmes et des océans

Canadian Science Advisory Secretariat (CSAS)

Proceedings Series 2015/055

Pacific Region

Proceedings of the Pacific regional peer review on the Development of risk-based Indicators for SGaan Kinghlas-Bowie Seamount and Endeavour Hydrothermal Vents Marine Protected Areas using the Ecological Risk Assessment Framework

May 20-21, 2015
Nanaimo, British Columbia

Chairperson: John Holmes
Editor: Nadja Steiner

Fisheries and Oceans Canada
Pacific Biological Station
3190 Hammond Bay Road
Nanaimo, B.C., Canada, V9T 6N7

December 2015

Canada

Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

Published by:

Fisheries and Oceans Canada
Canadian Science Advisory Secretariat
200 Kent Street
Ottawa ON K1A 0E6

http://www.dfo-mpo.gc.ca/csas-sccs/
csas-sccs@dfo-mpo.gc.ca

© Her Majesty the Queen in Right of Canada, 2015
ISSN 1701-1280

Correct citation for this publication:

DFO. 2015. Proceedings of the Pacific regional peer review on the Development of risk-based Indicators for SGaan Kinghlas-Bowie Seamount and Endeavour Hydrothermal Vents Marine Protected Areas using the Ecological Risk Assessment Framework; May 20-21, 2015. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2015/055.

TABLE OF CONTENTS

SUMMARY iv

SOMMAIRE v

INTRODUCTION 1

GENERAL DISCUSSION 2

APPLICATION OF THE INDICATOR SELECTION FRAMEWORK 3

Review of Specific Stressors 4

INDICATOR SELECTION AND PRIORITIZATION 5

MONITORING PROTOCOLS 6

Indicator Thresholds 6

Monitoring and Conservation Objectives 6

INFORMATION GAPS 7

Baseline Data Acquisition 7

CONCLUSIONS 8

RECOMMENDATIONS AND ADVICE 9

ACKNOWLEGEMENTS 10

APPENDIX A: TERMS OF REFERENCE 11

APPENDIX B: PARTICIPANTS 14

APPENDIX C: AGENDA 15

APPENDIX D: WORKING PAPER SUMMARIES 17

APPENDIX E: WRITTEN REVIEWS 19

APPENDIX F: SUGGESTED WORKING PAPER REVISIONS 25

SUMMARY

These proceedings summarize the relevant discussions and key conclusions that resulted from a Fisheries and Oceans Canada (DFO), Canadian Science Advisory Secretariat (CSAS) Regional Peer Review (RPR) meeting on 20-21 May 2015 at the Pacific Biological Station in Nanaimo, British Columbia. Two working papers were presented for review that describe a framework for identifying risk-based indicators based on outputs from the ecological risk assessment framework (ERAF) developed in the Pacific Region and propose suites of risk-based indicators for the Endeavour Hydrothermal Vents and SGaan Kinghlas-Bowie Seamount Marine Protected Areas.

In following with the request for science advice, the working papers:

1. Provide criteria and methods for prioritizing and selecting monitoring indicators; and
2. Use the criteria and methods to develop proposed suites of monitoring indicators for Endeavour Hydrothermal Vents and SGaan Kinghlas-Bowie Seamount Marine Protected Areas.

The working papers also included information to address the request for advice regarding:

3. The applicability of the proposed protocols for measuring the highest ranked interaction indicators in each marine protected area; and
4. Information gaps for indicators and potential approaches to address these gaps.

Two Science Advisory Reports were developed to provide science advice on the indicator selection framework and the proposed suites of indicators for each Marine Protected Area.

Staff from DFO Ecosystems and Oceans Science and Ecosystems and Fisheries Management Sectors, and representatives from First Nations, commercial and recreational fishing sectors, non-governmental organizations, and academia participated in the meeting either in person or remotely via webinar.

The conclusions and guidance resulting from this review were provided in the form of two Science Advisory Reports (SAR) to inform the development of operational conservation objectives, monitoring strategies and plans for the Endeavour Hydrothermal Vents and SGaan Kinghlas-Bowie Seamount Marine Protected Areas. The Science Advisory Reports and the Research Documents will be made publicly available on the CSAS Science Advisory Schedule.

Compte rendu de l'examen par les pairs régional du Pacifique sur l'élaboration d'indicateurs fondés sur les risques pour les zones de protection marine du mont sous-marin Bowie (SGaan Kinghlas) et du champ hydrothermal Endeavour à l'aide du cadre d'analyse du risque écologique

SOMMAIRE

Le présent compte rendu résume les discussions pertinentes et les principales conclusions qui découlent de la réunion d'examen par les pairs de la Région du Pacifique, du Secrétariat canadien de consultation scientifique de Pêches et Océans Canada (MPO), qui a eu lieu du 20 au 22 mai 2015 à la Station biologique du Pacifique de Nanaimo, en Colombie-Britannique. Deux documents de travail ont été présentés aux fins d'examen. Ces documents décrivent un cadre visant à déterminer les indicateurs fondés sur les risques basés sur les résultats du cadre d'évaluation du risque écologique (CERE) élaboré dans la Région du Pacifique et proposent des séries d'indicateurs fondés sur les risques pour les zones de protection marine du mont sous-marin Bowie (SGaan Kinghlas) et du champ hydrothermal Endeavour.

Pour donner suite à la demande d'avis scientifiques, les documents de travail :

1. Fournissent les critères et les méthodes pour le classement prioritaire et la sélection des indicateurs de surveillance;
2. Utilisent ces critères et ces méthodes pour élaborer des propositions de séries d'indicateurs de surveillance pour les zones de protection marine du mont sous-marin Bowie (SGaan Kinghlas) et du champ hydrothermal Endeavour.

Les documents de travail comprennent également des renseignements visant à répondre à la demande d'avis concernant :

3. L'applicabilité des protocoles proposés pour la mesure des indicateurs d'interaction les mieux classés dans chaque zone de protection marine;
4. Les lacunes dans les données pour les indicateurs et les approches envisageables pour combler ces lacunes.

De plus, deux avis scientifiques ont été élaborés afin de fournir des conseils sur le cadre de sélection des indicateurs ainsi que les séries d'indicateurs proposées pour chaque zone de protection marine.

Le personnel du Secteur des sciences des écosystèmes et des océans et du Secteur de la gestion des écosystèmes et des pêches du MPO ainsi que des représentants des Premières Nations, des secteurs de la pêche commerciale et récréative, des organisations non gouvernementales et du milieu universitaire ont participé à la réunion soit en personne, soit à distance grâce à un webinaire.

Les conclusions et les conseils découlant de cet examen ont été présentés sous la forme de deux avis scientifiques (AS) qui serviront à orienter l'élaboration d'objectifs de conservation, de stratégies et de plans de surveillance opérationnels pour les zones de protection marine du mont sous-marin Bowie (SGaan Kinghlas) et du champ hydrothermal Endeavour. L'avis scientifique et le document de recherche à l'appui seront rendus publics dans le calendrier des avis scientifiques du SCCS.

INTRODUCTION

A Fisheries and Oceans Canada (DFO) Canadian Science Advisory Secretariat (CSAS), Regional Peer Review (RPR) meeting was held on May 20-22, 2015, at the Pacific Biological Station in Nanaimo to review two working papers that developed and applied a framework for prioritizing and selecting indicators and propose suites of risk-based indicators for the Endeavour Hydrothermal Vents (EHV) and SGaan Kinghlas-Bowie Seamount (SK-B) Marine Protected Areas (MPAs). John Holmes was the Chair for the meeting.

The Terms of Reference (TOR) for the science review (Appendix A) were developed in response to a request for science advice from DFO Ecosystems and Fisheries Management, Oceans Program. Notification of the science review and conditions for participation were sent to representatives with relevant expertise within DFO Pacific Region and First Nations, the Government of British Columbia, commercial and recreational fishing sectors, non-governmental organizations, and academia (Appendix B).

John Holmes welcomed participants and invited them to introduce themselves and give their affiliation. Nadja Steiner was identified as the Rapporteur and tasked with drafting these proceedings. She was assisted by Evelyn Chen. The Chair reviewed the role of CSAS in the provision of peer-reviewed advice, and gave a general overview of the CSAS process. He also discussed the role of the participants, the purpose of the various RPR publications (Science Advisory Report, Proceedings, and Research Document), and the definition and process around achieving consensus decisions and advice, noting that the meeting was a science review and not a consultation. The Chair reviewed the Terms of Reference for the meeting and a revised Agenda (Appendix C). It was confirmed that copies of the Terms of Reference, working papers, and a meeting agenda had been distributed to participants prior to the meeting.

The following working papers (WP) were prepared and made available to meeting participants prior to the meeting (see Appendix D for summaries of each WP):

> Development of Risk-Based Indicators for Endeavour Hydrothermal Vents Protected Area by Kate Thornborough, Jason Dunham, and Miriam O. CSAP Working Paper 2014OCN004
>
> Development of risk-based indicators for SGaan Kinghlas-Bowie Seamount Marine Protected Area by Kate Thornborough, Jason Dunham, and Miriam O. CSAP Working Paper 2014OCN004

All participants were invited to join fully in the discussion and to contribute their knowledge to the process, including the development of the SARs, with the goal of delivering scientifically defensible conclusions and advice. Participants were reminded that everyone at the meeting had equal standing and that they were expected to contribute to the review process, if they had information or questions relevant to the paper being discussed.

Written reviews of the working papers were provided by Rosaline Canessa, Sean MacConnachie, and Candice St. Germain (Appendix E). The goal of soliciting these reviews was to inform, but not limit, discussion by participants attending the review. Copies of the written review were made available to participants prior to the meeting.

The conclusions and advice resulting from this review will be provided in the form of two Science Advisory Reports (SARs), used in the development monitoring strategies and plans for the EHV and SK-B MPAs. The SARs and the supporting Research Documents will be made publicly available on the CSAS Science Advisory website.

PRESENTATION OF THE WORKING PAPERS

Working Papers: Development of Risk-Based Indicators for Endeavour Hydrothermal Vents Protected Area by Kate Thornborough, Jason Dunham, and Miriam O. CSAP Working Paper 2014OCN004

Development of risk-based indicators for SGaan Kinghlas-Bowie Seamount Marine Protected Area by Kate Thornborough, Jason Dunham, and Mariam O. CSAP Working Paper 2014OCN004

Rapporteurs: Nadja Steiner and Evelyn Chen

Presenter(s): Kate Thornborough

The working papers (WPs) were presented by the lead author, Kate Thornborough. The framework and its application are similar in both WPs so these sections were presented together. It was pointed out that the selection of indicators was based on broad conservation goals for each MPA and the key was to develop scientifically defensible indicators with measurable components which can then feed into the development of monitoring strategies. This meeting deals only with the risk-based indicators; significant ecosystem components (SECs), stressors and interactions were prioritized based on risk and uncertainty estimated using the ERAF and assigned into one of three risk categories (low, moderate, high). The "low" category was filtered out and not considered further. Some indicator selection criteria (e.g., public awareness) were not used, but were added in the appendix of the WP for future reference.

The environment of the two MPAs, SGaan Kinghlas-Bowie Seamount (SKB) and Endeavour Hydrothermal Vents (EHV), was described and their uniqueness pointed out.

> SKB: A broad conservation objective applies to a unique offshore environment encompassing deep water and coastal species. Attention was drawn to the cumulative risk which is higher for benthic species than for more mobile species and fish. The main disturbances identified are oil spills, seismic activity and discharge.
>
> EHV: This seismic dominated vent region is characterized by low disturbance and high biodiversity. There is very little bottom fishing in the area because the MPA is located at considerable depth and fishing in the surface waters does not impact the bottom, therefore fishing was not included in the risk assessment. Primary disturbance comes from research activities, with sensitive invertebrates and tube worms at highest risk. The main stressors are oil, discharge, submersibles, sampling and aquatic invasive species.

The main information gaps identified during the indicator selection process were the lack of baseline information (see below) and the lack of operational objectives. Population size (abundance) and condition were identified as the main indicators in both areas and establishing a baseline for each MPA was noted as a priority.

The authors stressed that both potential and current snapshot indicator suites are necessary to provide a full picture for monitoring. The authors also highlighted the fact that a suite of indicators is needed to allow alternative options for monitoring. At this point the authors tried to cover all the basics to allow for a contingency plan. The capability/feasibility to measure an indicator was also taken into account for the indicator choice.

GENERAL DISCUSSION

Limited discussion followed the presentation of the working papers and was continued with the discussion of the written reviews (Appendix E). Reviewers also provided annotations directly

within the WP documents, which were provided to the authors. The reviewers were positive with compliments for compiling such a large amount of information. Some caution was voiced with respect to the potential of components falling through the cracks, when downscaling large amounts of information. Methods were approved and indicators deemed scientifically defensible. Some of the main discussion points are highlighted below. The proposed suites of indicators and their measureable components are outlined for each MPA in Appendix G.

APPLICATION OF THE INDICATOR SELECTION FRAMEWORK

Clarification was requested with respect to the differences between current and potential indicators. Current indicators are proposed for current snapshot stressors, which occur predictably in most years and for which some information on exposure and consequences is known and potential indicators are for potential stressors, which are unpredictable in their occurrence and have a much longer interval between occurrences than current snapshot stressors and thus exposure and consequence are estimated on a worst-case scenario basis. Current indicators are the most informative and are measured regularly whereas potential indicators are rarely measured, so little information is available and uncertainty is high.

Some clarification was required with respect to the filtering applied to the indicator selection process. It was explained that the filtering was based on the risk scores estimated for the SECs and stressors with the ERAF and in those cases in which the distribution of scores exhibited a long tail to the right, a large number of low risk SECs/stressors and indicators were filtered out. It was suggested that adding a figure representing the spread of the risk scores with a more detailed description in the WP would be a useful. One reviewer requested that the authors make the prioritizing more explicit (so that the indicator list does not look like a shopping list), however the difficulty of cutting out too much was noted and it was recommended that the longer list be retained at this stage of the process, because operational conservation objectives have not been defined yet.

Public awareness not used as an indicator selection criterion by the authors due to the concern that it would distract from looking at the components that are ecologically significant versus the charisma of the component. There was discussion on the pros and cons of this decision. It was concluded that the public awareness criterion should be kept out of the indicator criteria list at this stage of the process. However, it was suggested that public awareness could be used to prioritize or could be an additional indicator to be added later. There was some confusion with respect to public awareness versus the easily understandable for public and management selection criterion and this confusion was cleared up.

A question was asked about the inclusion of the recently discovered Sponge species at SKB in the indicator species selection process. This led to the clarification that only SECs (including species) that have been through the ecological risk assessment process (ERAF) could be considered in the risk-based indicator framework. It was decided that new species or known species which have only recently been found to provide good indicators, should be included in the future applications of the risk assessment and indicator selection frameworks. At this point they will only be mentioned in the future work section of the WP (examples are the newly discovered Glass Sponge *Doconesthes dustinchiversi at the* SKB MPA and the predatory Snail *Buccinum thermophilum* in the EHV MPA). The need to improve/streamline the procedure to include new species or species which are only belatedly recognized to be good indicators in a faster way was pointed out and it was highlighted that one of the main outcomes of this CSAP process is the identification of gaps and/or lack of knowledge.

It was clarified that the discharge stressor refers to vessel traffic. Furthermore, it was noted that some stressors ranked as high risk because they have not been put into separate categories

(e.g., debris) and the scores had to be determined based on a worst case scenario. It was also noted that the footprint on the surface of the ocean for some stressors might not be identical to the impacted area on the ocean floor (e.g., surface spill versus impact on sea floor, redistribution or dispersion via currents).

Clarification was requested with respect to risk based indicators (RBI), which were selected entirely from the previous risk assessment and respective SEC interactions, and ecosystem indicators (ESI) which encompass a broader range of driver-stressor responses and changes from natural drivers. Further discussion led to agreement that a discussion of the differences can be kept short in the WPs and covered via reference to the risk assessment report. Climate change impacts were not included because the WPs directly focused on what can be managed within an MPA. It was also pointed out that the stressors might need to be separated further in subsequent assessments.

Clarification was required with respect to chronic and acute risk. Both are taken directly from the ERAF output, with 'acute' risk directly linked to mortality and 'chronic' risk linked to changes in fitness and indirect effects on a SEC.

It was also clarified that an absolute ranking of risk was avoided. Instead a table listing things from highest to lowest priority was used. It was agreed that this is more useful than assigning numbers at this stage.

A point of discussion on the EHV WP was how to relate areal coverage to MPA as an indicator. The appropriate approach is unclear. Looking at the proportional area of the MPA is not appropriate due to the patchiness of the area (e.g., if one chimney area containing a breeding colony is crushed, then the damage might be much worse relative to the crushing of a non active chimney). The suggestion for an index of critical habitat was made, but not evaluated further. It was pointed out that current management in the EHV MPA is focused on vent fields (management objectives vary by vent field as described in the management plan) with sampling intensity and sampling activity (type) varying by vent field. The need to think of the bigger picture was pointed out: e.g., in case of substrate disturbance, the biggest issue is an alteration of the fluid flow and the resulting impacts on the benthic community as a whole. This means a disturbance might harm many organisms even though they weren't targeted or lived in the targeted area. It was pointed out that this is a secondary effect and so far only primary effects have been examined. However, because the impact of substrate disturbance could be high, it was recommended that alteration of fluid flow be included as an indicator and that it be included in any future ERAF application.

A question was asked about setting up indicators to clearly decouple natural and anthropogenic impacts. There was no clear resolution to this question since this decoupling is related to ecosystem indicators (see discussion under Monitoring).

Review of Specific Stressors

The issue of deep-sea mining as an additional stressor came up in the EHV MPA. The impact of mining was not deemed an issue at the time that the ERAF was conducted, but it was noted as a potential future risk and will be mentioned in the WP and SAR.

The question of the importance of fisheries at SKB came up. Bowie Seamount provides important habitat for many fish species such as Sablefish and Rockfish, which are harvested coast wide and migrate to SKB. The possibility for distinct or endemic species at the SKB exists, but no genetic information is available to confirm this hypothesis. It was suggested that an accurate fine-scale map of the fishing footprint at SKB is needed. The Sablefish trap fishery at SKB has a long history, however there are many concerns related to this fishery particularly

impacts on Corals and Sponges. Some work is ongoing with cameras on traps by the Sablefish association, but this work doesn't alleviate the concerns. The Coral and Sponge protocol requires that Coral bycatch in trap fisheries is collected and identified to species. Although this incidental catch can be used as sampling method, it is problematic because it is destructive. It was highlighted to make sure advantage is taken of what is already happening to avoid any further damage.

The Albacore Tuna fishery was mentioned with respect to SKB, but left out at this point since commercial Tuna fishing activity has not occurred within the MPA area. The Albacore Tuna fishery uses surface troll gear, which usually has among the lowest ecosystem impacts (low bycatch/low bird impact). However, recent observations show a northward shift in Albacore Tuna distribution and the issue might need to be revisited in the future if these shifts persist. In summary, it was agreed that a specific reference to Tuna was not needed in the WPs, but the authors should stress the need to obtain a better picture of biodiversity. This discussion led to the recognition of the need to improve the methods/protocols for habitat classification. It was noted that habitat classification is usually linked to conservation objectives. A thorough baseline study available for Gwaii Hanas and might help the development of MPA planning and zoning for SKB.

INDICATOR SELECTION AND PRIORITIZATION

One point of discussion was the use of the word biomass with respect to indicators. While commonly used, care needs to be taken not to confuse abundance and biomass. Biomass might be calculated from abundance rather than measured. Measuring biomass directly would mean repeated extractive sampling which should be avoided (non-destructive methods are preferred). It was noted that the use of biomass is partly historical. The biomass of a few large-bodied individuals may be similar to the biomass of many small-bodied individuals of the same species. Hence, a more useful, alternative measurement would be size structure which is also an indicator of population condition (e.g., information on recruits). Another measurement of population condition is reproductive condition, which might require some destructive sampling, but could be done visually at least for some species. It was added that a size structure baseline needs to be developed as indicator for future change. Some existing baseline information might allow linkage to reproductive success (e.g., tube diameter for tube worm species for EHV).

It was suggested to consider a tiered monitoring approach, where a more 'destructive' method (e.g., to determine biomass) might be Tier 2 and only applied if a 'non-destructive' method (e.g., visual abundance counts) show signs of concern. It was unclear how this tiered system to monitoring could be implemented since some changes in existing management approaches might be necessary. Any recommendations would need to go through an approval process first, hence at this point this will be a recommendation for future consideration only.

With respect to organism health, it was suggested to move the thinking towards community function rather than individual organism health, e.g., by implementing a functional index. Although this comment was related to the Clam SEC at EHV, it was suggested that more specific functional indices would need to be evaluated/set up with experts in the future.

Some discussion came up about using genetics as an indicator and the value with respect to informing managers. It was noted that even though genetics is a fairly new area, and potentially less known to management, the use of genetic indicators is of value and should remain in the list. For example, the decline or increase of genetic diversity may be an indicator of species or community health. Genetic diversity is often a criterion used for MPAs, e.g., as part of maintaining biodiversity. It was also noted that genetics can identify which species or area might require more protection, e.g., a breeding colony, and that measurement methods are becoming

easier and cheaper. It was, however, agreed that the indicator description should be more specific, e.g., rather than using only the word genetic, it should be genetic diversity (including information on sex ratio, inbreeding, etc.) with allele frequency, sequence divergence, polymorphism as measurable components.

It was stressed that in addition to noise level, the frequency (in Hz) of the noise is an equally important indicator to consider since some species exhibit frequency-specific responses to noise. References were provided and the point will be included by the authors of the SKB WP and in the SAR.

MONITORING PROTOCOLS

Indicator Thresholds

It was noted that indicator thresholds were not provided in the WPs because they are often associated with targets and objectives. The group agreed that setting indicator thresholds (e.g., catch limits at SKB) is beyond the scope of the WPs. Identifying these thresholds requires knowledge of ecosystem indicators and thresholds based on changes in environmental variables (e.g., temperature) and potential tipping points in response to stressors.

Monitoring and Conservation Objectives

It was clarified that the goal of this process is to provide management advice for the development of monitoring strategies. The WPs contain the scientific advice on risk based indicators. Decisions on which indicators to use for monitoring will be based on operational conservation objectives defined for each MPA. It was stressed that potential and current stressors might need different monitoring strategies.

It was suggested that since the EHV MPA is currently managed by vent field, then it might make sense to develop a monitoring plan along those lines. Some clarification with respect to the description of the sampling unit will be required, since it is not easy to address with respect to areal coverage (see above). Also, there is no obvious control versus impact area. It was concluded that delving into the sampling unit is beyond the scope of the paper but it will need to be mentioned that the relevant sample unit should be determined.

It was highlighted that an understanding of natural variability would aid the development of long term monitoring and management planning, i.e., how does the community change over time in the absence of anthropogenic stressors? This kind of understanding is needed so that natural variability in community development can be distinguished from anthropogenically induced variability, which would be the focus of management. Gaining this understanding should be a target for assessing past information (note that the availability of past information is a major difference between EHV and SKB).

It was recommended that more distinct and clear recommendations be provided to management in the WPs and the authors would like more feedback on what recommendations can be used by managers.

Some discussion occurred on the sequence of developing conservation objectives and developing monitoring strategies. It was recommended that work on operational objectives which can feed into the conservation priorities based on risk, be started, but will then need the result of the full ERAF risk assessment, including risk-based and ecosystem-based indicators, to better define the conservation objectives.

The discussion of Ecosystem Indicators (ESI) was related to the above. It was pointed out that the current process is only one part of the issue. ESIs are an essential part of the monitoring

strategy and plan: monitoring the larger scale drivers is important, but missing from this is a risk-based indicator assessment. The recommendation for the future is to deal with that part. Hence, it is difficult to decide on the actual methodology for a final monitoring strategy. The risk-based indicators can be used to start the implementation of some monitoring plans, remaining aware that a component is missing. It was pointed out that it was deemed important to look at anthropogenic stressors first, where management may have some control. This will allow the development of management protocols to begin while being aware that there are additional stressors that will also affect ecosystem resilience, but for which management has little or no control.

In that context the need for baseline information was again stressed, this time with the intent to evaluate potential driver(s) of change. Without the ESI's this is not possible. Many criteria are the same for RBIs and ESIs, but the filtering mechanism is different and the ESIs need more specific objectives.

INFORMATION GAPS

It was stressed that there is an urgent need to establish a biological baseline for future monitoring. While some data mining (re-evaluation of existing material) might be possible, it is believed that few historical data are available for SKB. In contrast, data mining may be highly valuable for EHV where data collection/observation activities dating back to the early 1980s are known to have occurred. It was stressed that data mining will require someone to identify the data sources and do the analysis (time and money), but for EHV some sort of baseline can probably be established that way.

It was pointed out that historical oceanographic and hydrographic data as well as stressor exposure data are limited also, particularly for SKB. It was noted that a project is under way to look at vessel traffic and noise including hydrographic surveys, in SKB, an area where baseline data are lacking.

The lack of habitat mapping was emphasized. There are currently no plans or funding to close that gap (other than the cameras attached to Sablefish traps at SKB, although the information transfer is vague).

The question of how to determine the area of damage was asked, e.g., for Sablefish trap fishing it might not be obvious if the damage occurred from the trapping activity. One suggestion was to compare impacted areas to a control site and to compare different areas. It was also stressed that one indicator alone is not sufficient, rather, multiple indicators need to be monitored.

There is an issue (long time scale) with including new species as indicators, since they need to go through the ERAF analysis first, rather than being considered from an ecosystem indicator point of view. It was questioned how new species (either newly found or identified as sensitive to certain conditions and hence useful as indicators for monitoring) can be included into the framework in a faster way. It was noted that at EHV almost all species are new species and endemic, but some might be more useful as indicators.

The lack of conservation objectives was pointed out and is discussed in the previous section.

Baseline Data Acquisition

A recurring issue pointed out by the authors is the lack of baseline data against which indicators can be evaluated. It was pointed out that there may be existing biological baseline data, e.g., in form of existing videos, which might have been evaluated with a different question in mind. These data sources should be revisited and evaluated in support of creating baseline information. This issue is particularly relevant for EHV, where videos and measurements have

been taken since 1984. It was noted that most of the material is likely available from Woods Hole Institute of Oceanography (WHOI) and possibly with the Canadian Submersible Association. More recent data are available as part of the joint Ocean Network Canada (ONC – DFO) data collection process. ONC runs the Neptune cabled observatory off the west coast of Vancouver Island and has a node in the EHV MPA. Videos since 2010 are accessible online. It was pointed out that some analysis of recent data is still ongoing but progress is slow and requires time and money. It was clarified that the term visual surveys refers to video material, which can be evaluated both for abundance (counts/m^2) as well as for species diversity. Generally, however it was recommended to keep the term visual surveys more general so that potential new technologies are not excluded. At present, acquiring baseline data heavily relies on video, since it allows capturing multiple information streams at once (i.e., it's cost efficient). Some worry has been voiced with respect to loosing material with retirements, etc. For example, there is no proper specimen repository in Canada and a 30 year species collection from EHV MPA housed at the University of Victoria will now leave the country. Another point mentioned was the need for a meta data base to avoid overlap and duplication of measurements and reduce the impact of sampling stressors. Some shared information bases have been established, e.g., DFO ships information to coordinate cruise planning. A set of guidelines to be included with a research permit was also suggested.

Available ROV data from SKB are sparse and have not been analyzed (first surveys were in the 1990s looking at viability of fishing). Trap fishing is only done at Bowie Seamount (the highest of the three seamounts within the SKB MPA). Biodiversity is highest at Bowie, but the other seamounts are not really comparable since they are much deeper than Bowie (1000m vs. 60m). This means that the other seamounts are not in the photic zone, but still within the range of Sponges. There is some potential to compare the other seamounts as controls for fishing with the fished Bowie Seamount and a proposal to do this kind of comparative sampling on an upcoming cruise was developed. There is also interest in analyzing new species, either visually or possibly with low destructive sampling.

Very little oceanographic research has been conducted at SKB (some cruises in the late 70s with diving, etc.). Limited multibeam and scatterometer work has been done to a certain depth. A cruise to conduct a multibeam survey to a larger depth is in the planning stages.

Oceanographic and bathymetric background data are more extensive at EHV.

CONCLUSIONS

A draft SAR for each MPA was prepared by the Chair and WP authors and distributed to participants at the end of the first day. The Chair noted that the intent of these draft documents was to identify the different sections of these documents and the type of information captured in those sections. The Chair briefly reviewed the process of capturing science advice in the SAR as it relates to conclusions, sources of uncertainty, recommended future work, and working paper caveats or revisions and asked participants to review the draft SARs and identify changes to existing wording, additions, deletions, and other issues for discussion the following day.

The draft SAR for the EHV MPA was projected on-screen for all participants to see on the following day. The Chair briefly reiterated the process of capturing science advice and conclusions in the SAR and noted that the Summary section is particularly important as it is posted on the CSAS website and should contain all of the main observations, conclusions, uncertainties, advice and recommendations from the RPR. He also noted that it was good practice when developing the summary section and conclusions to craft points that related directly to each of the objectives identified in the TOR for the meeting. Finally, it was noted that much of the text in the draft SARs was similar so the meeting would review the EHV MPA SAR

in detail and then briefly review the SKB MPA SAR to ensure that site specific details and points were captured.

Meeting participants worked through the draft SAR for the EHV MPA and made some revisions/additions to text in the Summary, Sources of Uncertainty, Conclusions and Advice Sections based on the discussions described earlier in this document. It was recommended that a brief discussion of ecosystem indicators (as opposed to risk-based indicators) be included in the SAR and that the measurable components tables in the Appendices of the WPs (Appendices C,F, and J) be added as an appendix to the relevant SAR because they provide information on how to measure indicators. Finally, the Chair led participants in a discussion about whether the WPs and the RPR met the objectives in the TOR. Meeting participants agreed that all TOR objectives were addressed within the limits and capabilities of the group. The same process was applied to the SAR for the SKB MPA.

There was consensus among meeting participants that both WPs are acceptable for publication, subject to minor revisions identified in the formal reviews (Appendix E) and recorded during the meeting (Appendix F). It was clarified and confirmed with participants that it is not mandatory for the authors to incorporate all of the revisions identified by the reviewers and meeting participants. It was agreed that the authors and Chair, acting as editor, implement and approved the revised WPs. If the authors decide to not include a particular revision, then an explanation will be provided for the Chair to review and approve.

Lastly, the Chair briefly explained the expected process for document preparation, review and approval. The Chair will forward the revised SARs to meeting participants to review within two weeks of the meeting. Comments will be incorporated into the SARs, where appropriate, and the finalized version forwarded to the CSAS office in PBS for approval. The proceedings will be prepared by the rapporteur, Nadja Steiner, with assistance from the Chair and forwarded for review to participants within about one month of the meeting. The Chair and the WP authors will ensure that the WPs are revised accordingly.

RECOMMENDATIONS AND ADVICE

There was consensus that the methodology for identifying risk-based indicators is suitable for the intended purpose and that the description of procedures and the decision making process incorporated in the framework supports the achievement of comparable outcomes among users and when applied to other MPAs or management units

There was consensus that the suites of risk-based indicators proposed for current snapshot stressors (predictable, and occurring most years) and potential stressors (unpredictable, and occurring infrequently) in both MPAs are suitable to support the development of strategies and plans to monitor human impacts in the each MPA.

It was recommended that indicator sampling protocols in both MPAs focus on non-destructive sampling methods, including remote tools such as cabled observations and ROVs. A tiered approach is recommended to minimize the frequency and extent of destructive monitoring, e.g., to estimate SEC biomass, to those periods/places identified by ongoing visual monitoring.

An iterative approach was recommended for the development of operational conservation objectives (i.e., taking existing policy statements and developing goals that can be measured and used to evaluate management performance) and further refine the list of proposed indicators and select ecosystem indicators for each MPA.

ACKNOWLEGEMENTS

The Chair thanked the reviewers, Rosaline Canessa, Candace St. Germain, and Sean MacConnachie, for their expertise and valuable reviews of the working papers, the authors for producing two well executed WPs, and all of the participants for their constructive engagement in the science review process at this meeting. Nadja Steiner and Evelyn Chen were thanked for being rapporteurs. Lesley MacDougall's assistance in helping lead discussion on information to include in the SAR is greatly appreciated as is Ann Mariscak's assistance in providing logistics support for the meeting.

APPENDIX A: TERMS OF REFERENCE

Development of risk-based Indicators for SGaan Kinghlas-Bowie Seamount and Endeavour Hydrothermal Vents Marine Protected Areas using the Ecological Risk Assessment Framework

Regional Peer Review Process – Pacific Region
May 20-21, 2015
Nanaimo, British Columbia

Chairperson: John Holmes

Context

Canada's Oceans Act and Oceans Strategy commit Fisheries and Oceans Canada (DFO) to lead the development and implementation of a sustainable, precautionary and integrated ecosystem approach to oceans management. An important step toward meeting these commitments is the application of a risk-based framework to identify and prioritize management issues and inform the development of conservation objectives, management strategies and action plans for Large Ocean Management Areas (LOMAs) and Marine Protected Areas (MPAs).

A five-step framework based on Pathways of Effects (POE) and Ecological Risk Assessment methods was developed by DFO Science for the identification of indicators (Davies et al. 2011 a+b) and reviewed at a Canadian Science Advisory Secretariat-Pacific (CSAP) Regional Peer Review (RPR) meeting in October 2010 (DFO, 2011a+b). A preliminary POE was conducted for human activities currently occurring at SGaan-Kinghlas – Bowie (SK-B) (DFO, 2011a) and Endeavour Hydrothermal Vents (EHV) (DFO, 2011b) Marine Protected Areas (MPAs). The recommendations from this preliminary work were to:

- develop measurable Conservation Objectives;
- collect baseline data to complete an Ecological Risk Assessment Framework (ERAF) of identified stressors;
- implement comprehensive reporting, and;
- utilize a stressor-based indicator framework to identify appropriate indicators for monitoring the achievement of Conservation Objectives.

An ERAF was completed by DFO Oceans and Science staff in Pacific Region (O et al. 2014) and endorsed at a CSAP RPR meeting in May 2012 (DFO 2012). Following from the ERAF development, a Regional Peer Review held in June 2013 (DFO 2014) concluded that the Level 1 (qualitative) risk assessment performed well in identifying relative risk to Significant Ecosystem Components (SECs) and in providing information on the drivers of risk to SECs. A subsequent RPR was held in February, 2014 to evaluate the structure and performance of the semi – quantitative (Level 2) ERAF methodology relative to the prototype ERAF (O et al. 2014) and to develop a list of SECs for both the SK-B and EHV MPAs; ranked by their estimated risk scores resulting from exposure to human activities/stressors.

The ranked lists of SECs support the development of indicators to monitor progress against the achievement of conservation objectives in each MPA. Activities/stressors driving the risk scores inform the development of monitoring plans for each MPA. Conservation Objectives have not yet been developed for SK-B or EHV; however, the indicators proposed through this work are intended to be suitable for use once Conservation Objectives have been established. Management plans are currently under development for SKB and EHV MPAs.

DFO Oceans Program has requested Science Branch to identify risk-based indicators for SGaan Kinghlas-Bowie Seamount (SK-B) and Endeavour Hydrothermal Vents (EHV) Marine Protected Areas. The identification of indicators, monitoring protocols and strategies to assess the achievement of the conservation objectives (COs) is a key component of MPA planning and implementation in Canadian Pacific marine waters.

Objectives

The following working paper will be reviewed and provide the basis for discussion and advice on the specific objectives outlined below.

Thornborough, K., Dunham, J., O, M.: Development of risk-based indicators for Endeavour Hydrothermal Vents and SGaan Kinghlas-Bowie Seamount Marine Protected Areas. CSAP Working Paper 2014OCN004

The specific objectives of this review are to:

1. Assess the consistency and application of the criteria and methodology used to identify risk-based indicators based on the ERAF outputs for:
    a. SGaan Kinghlas-Bowie Seamount (SK-B)
    b. Endeavour Hydrothermal Vents (EHV)
2. Assess the indicator selections and their prioritization rankings for use at SK-B and EHV.
3. Assess the applicability of the proposed protocols developed for measurement of the highest ranked interactions indicators for SK-B and EHV.
4. Identify any remaining information gaps for indicators and potential approaches to address these gaps.

Expected Publications

- Science Advisory Report (2)
- Proceedings
- Research Document (2)

Participation

- Fisheries and Oceans Canada (DFO) Ecosystems and Oceans Science, Fisheries Management, Science
- Council of the Haida Nation
- Province of BC
- Academia / Invited experts
- Aboriginal communities/organizations
- ENGOs
- National Center for Ecological Analysis and Synthesis, United States National Oceanic and Atmospheric Association
- Fishing Industry

References

DFO. 2014. Pilot application of an ecological risk assessment framework to inform ecosystem-based management in the Pacific North Coast Integrated Management Area. DFO Can. Sci. Advis. Rep. 2014/026.

DFO. 2012. Risk-based assessment framework to identify priorities for ecosystem-based oceans management in the Pacific region. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/044.

DFO. 2011a. Endeavour Hydrothermal Vents Marine Protected Area Monitoring Indicators, Protocols and Strategies. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/035.

DFO. 2011b. SGaan Kinghlas-Bowie Seamount Marine Protected Area Monitoring Indicators, Protocols and Strategies. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/036.

Davies, S., O, M., Boutillier, J., 2011. Recommendations for indicator selection for Endeavour Hydrothermal Vents Marine Protected Area. DFO Can. Sci. Advis. Sec. Res. Doc. No. 2011/.068.

Davies, S., O, M., Boutillier, J., 2011. Recommendations for indicator selection for Sgaan Kinghlas Bowie Seamount Marine Protected Area. DFO Can. Sci. Advis. Sec. Res. Doc. No. 2011/.069.

O, M., Martone, R., Hannah, L., Greig, L., Boutillier, B. and Patton, S. 2014. An Ecological Risk Assessment Framework (ERAF) for Ecosystem-based Oceans Management in the Pacific Region. DFO Can. Sci. Advis. Sec. Res. Doc. No. 2014/072.

APPENDIX B: PARTICIPANTS

Last Name	First Name	Affiliation
Boutillier	Jim	DFO Science (Emeritus)
Bocking	Bob	LGL Ltd
Canessa	Rosaline	Uvic
Chen	Evelyn	DFO Science
Conley	Kevin	DFO Fisheries Management
Curtis	Janelle	DFO Science
Dunham	Jason	DFO Science
Hargreaves	Marilyn	DFO Centre for Science Advice Pacific
Hillier	Joy	EMB Oceans
Holmes	John	DFO Science-Chair
Ibey	Hilary	DFO Ecosystems Management Branch
Jones	Russ	Haida Oceans Technical Team
Keizer	Adam	DFO Fisheries Management
Macauley	Neil	DFO Science
MacConnachie	Sean	DFO Science
MacDougall	Lesley	DFO Centre for Science Advice Pacific
O	Miriam	DFO Science Ocean Sciences Division
Perry	Ian	DFO Science
Rubidge	Emily	DFO Science Ocean Sciences Division
Simms	Jason	DFO Resource Manager
Steiner	Nadja	DFO Science Ocean Sciences Division
Thornborough	Kate	DFO Science Ocean Sciences Division
Tunnicliffe	Verena	UVIC, Neptune

APPENDIX C: AGENDA

REGIONAL PEER REVIEW MEETING (RPR)

Centre for Science Advice Pacific

Development of risk-based Indicators for SGaan Kinghlas-Bowie Seamount and Endeavour Hydrothermal Vents Marine Protected Areas using the Ecological Risk Assessment Framework

May 20-21, 2015

Pacific Biological Station
Nanaimo, BC, V9T 6N7

Chairperson: John Holmes

DAY 1 - Wednesday, May 20

Time	Subject	Presenter
0900	Introductions Review Agenda & Housekeeping CSAS Overview and Procedures	Chair
0915	Review Terms of Reference	Chair
0930	Presentation of EHV and SKB Working Papers	Authors
1030	***Break***	
1050	Reviews	Chair + Reviewers & Authors
12:00	***Lunch Break***	
1300	Identification of Methodology Issues for Discussion	RPR Participants
1400	Discussion & Resolution of Methodology Issues	RPR Participants
1430	***Break***	
1445	Discussion & Resolution of Methodology Issues	RPR Participants
1630	**Adjourn for the Day**	

DAY 2 - Thursday, May 21

Time	Subject	Presenter
0900	Introductions Review Agenda & Housekeeping Review Status of Day 1	Chair
0915	Outstanding Issues from Day 1	RPR Participants
0930	Results and Conclusions – SK-B • Indicator selections and their prioritization rankings • Measurement protocols for highest ranked interaction indicators • Information gaps & approaches to address these gaps	RPR Participants
1030	***Break***	
1050	Results and Conclusions – EHV • Indicator selections and their prioritization rankings • Measurement protocols for highest ranked interaction indicators • Information gaps & approaches to address these gaps	RPR Participants
12:00	***Lunch Break***	
1300	Develop Consensus on Acceptability & Revisions for WPs	RPR Participants
1330	*Science Advisory Reports (SAR) for EHV & SK-B* Develop consensus on the following for inclusion: • Results & Conclusions • Sources of Uncertainty • Advice to Management	RPR Participants
1430	***Break***	
1450	Science Advisory Reports (SAR) for EHV & SK-B	RPR Participants
1450	Next Steps – Chair to review • SAR review/approval process and timelines • Research Document & Proceedings timelines • Other follow-up or commitments (*as necessary)*	Chair
1600	Other Business arising from the review	Chair & Participants
1630	**Adjourn Meeting**	

APPENDIX D: WORKING PAPER SUMMARIES

Development of risk-based indicators for Endeavour Hydrothermal Vents Marine Protected Area

Fisheries and Oceans Canada (DFO) Science was asked to recommend scientifically defensible indicators to monitor the achievement of the Endeavour Hydrothermal Vents Marine Protected Area (EHV MPA) conservation objective. In response, a framework was developed to select and prioritize risk-based ecological indicators based on the outputs of an ecological risk assessment conducted on the EHV MPA. Risk-based indicators are a novel approach to selecting indicators to monitor the risk of harm to Significant Ecosystem Components (SECs) from anthropogenic activities and associated stressors. Suites of risk-based indicators are proposed for current snapshot stressors (predictable, and occurring most years) and potential stressors (unpredictable, and occurring infrequently), and both incorporated SEC specific, stressor specific, and SEC-stressor interaction indicators. Suites of indicators, rather than one or two, are required to provide a better understanding of ecosystem structure and function and the risk of harm from anthropogenic stressors. This understanding enables future development of indicator thresholds and appropriate management actions. Measures of abundance were commonly proposed across all indicator suites, highlighting the need to establish baselines of information as a priority. Both current snapshot and potential stressor indicator suites should be considered when developing monitoring strategies and plans, using a combination of SEC, stressor, and SEC-stressor interaction indicators. Current snapshot indicator suites measure the SEC-stressor interaction directly and can be monitored at the same time as collecting general information to establish baselines and measure disturbances using SEC and stressor indicators. The monitoring of potential stressor indicator suites should occur in two steps: (1) establish baselines of information using SEC and stressor specific indicators; and, (2) if/when the potential stressor occurs, use SEC-stressor interaction indicators to measure the disturbance and compare with population baselines established in step 1. Due to the remote access and associated cost of monitoring indicators at EHV MPA, many of the suggested indicators may be measured using visual surveys, and the overlapping distribution of several SECs, multiple indicators may be measured or sampled during the same operations period. The selection of ecological risk-based indicators is a key step in the adaptive management (AM) framework for EHV MPA. The indicators selected during this process will be used to develop monitoring strategies, refine conservation objectives further into operational objectives, and develop monitoring plans. As data is collected through the monitoring of indicators, this information may be fed back into the adaptive management framework for future iterations of risk assessments, evaluation of selected indicators, selection of new indicators, and the refinement of the monitoring plans.

Development of risk-based indicators for SGaan Kinghlas-Bowie Seamount Marine Protected Area

Fisheries and Oceans Canada (DFO) Science was asked to recommend scientifically defensible indicators to monitor the achievement of the SGaan Kinghlas-Bowie Seamount Marine Protected Area (SK-B MPA) conservation objective. In response, a framework was developed to select and prioritize risk-based ecological indicators based on the outputs of an ecological risk assessment conducted on the SK-B MPA. Risk-based indicators are a novel approach to selecting indicators to monitor the risk of harm to Significant Ecosystem Components (SECs) from anthropogenic activities and associated stressors. Suites of risk-based indicators are proposed for *current snapshot* stressors (predictable, and occurring most years) and *potential* stressors (unpredictable, and occurring infrequently), and both incorporated SEC specific,

stressor specific, and SEC-stressor interaction indicators. Suites of indicators, rather than one or two, are required to provide a better understanding of ecosystem structure and function and the risk of harm from anthropogenic stressors. This understanding enables future development of indicator thresholds and appropriate management actions. Measures of abundance were commonly proposed across all indicator suites, highlighting the need to establish baselines of information as a priority. Both *current snapshot* and *potential* stressor indicator suites should be considered when developing monitoring strategies and plans, using a combination of SEC, stressor, and SEC-stressor interaction indicators. *Current snapshot* indicator suites measure the SEC-stressor interaction directly and can be monitored at the same time as collecting general information to establish baselines and measure disturbances using SEC and stressor indicators. The monitoring of *potential* stressor indicator suites should occur in two steps: (1) establish baselines of information using SEC and stressor specific indicators; and, (2) if/when the potential stressor occurs, use SEC-stressor interaction indicators to measure the disturbance and compare with population baselines established in step 1. Due to the remote access and associated cost of monitoring indicators at SK-B MPA, many of the suggested indicators may be measured using visual surveys, and the overlapping distribution of several SECs, multiple indicators may be measured or sampled during the same operations period. The selection of ecological risk-based indicators is a key step in the adaptive management (AM) framework for SK-B MPA. The indicators selected during this process will be used to develop monitoring strategies, refine conservation objectives further into operational objectives, and develop monitoring plans. As data is collected through the monitoring of indicators, this information may be fed back into the adaptive management framework for future iterations of risk assessments, evaluation of selected indicators, selection of new indicators, and the refinement of the monitoring plans.

APPENDIX E: WRITTEN REVIEWS

Written Review #1

Date: 15 May 2015

Reviewer: Sean MacConnachie, DFO Science, Pacific Biological Station, Nanaimo

Working Paper: Thornborough, K., Dunham, J., and O, M. Development of risk-based indicators for Endeavour Hydrothermal Vents Marine Protected Area. CSAP Working Paper: 2014OCN05

Objectives from the Terms of Reference:

1. Assess the consistency and application of the criteria and methodology used to identify risk-based indicators based on the ERAF outputs for:
   a. SGaan Kinghlas-Bowie Seamount (SK-B)
   b. Endeavour Hydrothermal Vents (EHV)
2. Assess the indicator selections and their prioritization rankings for use at SK-B and EHV.
3. Assess the applicability of the proposed protocols developed for measurement of the highest ranked interactions indicators for SK-B and EHV.
4. Identify any remaining information gaps for indicators and potential approaches to address these gaps.

GENERAL COMMENTS

As with previous works, the authors of this paper should be commended for undertaking a novel approach in a new area for DFO science. The paper builds on previous works that will ultimately inform the development of operational MPA objectives. My review only speaks to the EHV component of the terms of reference.

EHV-MPA is a very difficult place to get to and a very difficult environment to work in. As a result our knowledge and understanding of how this ecosystem functions is very data limited and the interactions between activities, their stressors, and the impacts on different ecosystem components is primarily based on observations on other systems, experts opinions and speculation. With this basis, the authors have provided a series of indicators that appear to be not always specific to EHV. In the paper it wasn't always clear if the indicators would actually be useful for managers to implement or were more of a shopping list. The prioritization is based on the SEC-Stressor interaction and the proposed indicators don't appear to have any further prioritization. I don't that this is an issue but the authors may want to make this more explicit.

In reviewing this paper I found most of my concerns are editorial in nature, and it is in that spirit that I provide the following comments. Given that this is a continuum of work I found the authors have repeated what has been accomplished in other papers to tell a more fulsome story. The problem with this approach is that it makes the paper a bit cumbersome. For a new area of science advice I suggest the authors keep is simple whenever possible. I have provided a marked MS Word version for edits but I will provide specific comments for discussion. The paper is comprised of two parts, the paper and the appendices that contain the bulk of the work.

I have broken my review into the two components and followed the structure of paper in my review.

ABSTRACT

The abstract is too long. There is far too much explanation and justification for the approaches taken. I suggest including the two or three key indicators that have been recommended and the associated issues and a couple bullets from the conclusion.

CONTEXT

Last paragraph can be removed as it is repetitive

1.2 INDICATORS

The information about ecosystem indicators can be removed. This paper is about risk-based indicators. I suggest for brevity just say what ecosystem indicators are, and say that it is beyond the scope of this paper.

2.1 Description of Endeavour Hydrothermal Vents Marine Protected Area

Can this section be reduced to one paragraph? Highlight the absolute key feature that the rest of the document hinges on?

2.2 Conservation Objective

This section can be blended with the intro/introduction

2.3 Current activities and management

Inclusion of text from the Oceans Act doesn't add anything to the paper.

2.4 Current monitoring in the MPA

Second paragraph is about management and should be in section 2.3

3. Methods

Last paragraph is redundant.

4.1.1. Prioritization of Significant Ecosystem Components

Wasn't this step completed in the previous work? If so just cite the paper.

4.1.2. Proposed indicators for Significant Ecosystem Components

"Selected indicators and their measureable components for SECs are presented in Appendix C.": I suggest adding this table directly into the paper. Makes it easier to read.

4.1.INDICATOR IDENTIFICATION FOR STRESSORS (Note numbering is no longer in order)

4.1.1. Prioritization of anthropogenic stressors

Wasn't this step completed in the previous work? If so just cite the paper.

4.1.2. Proposed indicators for Significant Ecosystem Components

"Selected indicators and their measureable components for SECs are presented in Appendix F": I suggest adding this table directly into the paper. Makes it easier to read.

5.3. LIMITATIONS AND FUTURE DEVELOPMENT OF THIS WORK

This entire section although very informative could be summed up in the statement that as we learn more indicators can and will change. I recommend condensing down this section into a succinct paragraph.

5.3.1. Conservation objectives

Although these paragraphs are interesting and true, not really needed for this paper

5.3.2. Ecosystem indicators

Although these paragraphs are interesting and true, not really needed for this paper

APPENDICES

APPENDIX B: RISK-BASED INDICATOR SELECTION CRITERIA

Is this table for all MPAs or EHV specifically? If it a general list please be explicit. Theoretically sound: This is more of an overriding attribute for all criteria. The sub-criteria is a summation of criteria #2

APPENDIX C: PROPOSED INDICATORS FOR SECS

Community species richness and diversity: Diversity measures (e.g. Shannon Simpson, taxonomic redundancy, taxonomic distinctness) applied to the assemblages of species. These are a community/ecosystem indicator (I think)

Genetics- Population delineations: It's unclear what genetics would show. I don't think it would be feasible to see a change in genotype in a species over the course of MPA management time

Appendix D: SEC indicator justifications

Community species richness and diversity Community species richness and diversity measures (e.g. Shannon Simpson, taxonomic redundancy, taxonomic distinctness) applied to the assemblages of species. This is a community/ecosystem indicator (I think)

Appendix E: SEC indicator criteria summary

Catch and by-catch data are fishery-dependent and are biased toward fisher behavior, fleet dynamics, and management restrictions (Andrews et al. 2013). Not really relevant to Endeavour

APPENDIX F: PROPOSED INDICATORS AND MEASUREABLE COMPONENTS FOR ACTIVITIES AND ASSOCIATED STRESSORS

Submersible operations/substrate disturbance/maximum increased turbidity How will it be possible to measure this in real time. If NTUs increase in the short term does that affect management response. Not sure of this is feasible/meaningful

Oil spill/Oil/Oil type/ Determines surface, water column, or benthic coverage. E.g. bitumen – surface coverage of benthic habitats, petroleum – surface spill only. If there was a spill on the surface at EHV, I think it's very low probability of the sinking oil to actually hit the MPA. Is this a meaningful indicator?

Appendix H: SEC-stressor interactions and results of the prioritization method

I believe appendix H is from previous works. If so it should be cited, or it can be removed entirely.

APPENDIX I: ORIGINAL SCORING AND JUSTIFICATIONS OF TOP SEC-STRESSOR INTERACTIONS (KEY PARAMETER DRIVING RISK)

Portions of Appendix I have copied over from previous works. I'm not sure why they have been added to this document, and simply not cited in the text.

Thank you for the opportunity to review your paper. It was an interesting read and should help Oceans managers develop operational objectives for Endeavour and other MPAs.

Written Review #2

Date: May 18, 2015

Reviewer: Candice St. Germain

Working Paper: Thornborough, K., Dunham, J., and O, M. Development of risk-based indicators for Endeavour Hydrothermal Vents Marine Protected Area. CSAP Working Paper 2014OCN05.

Review:

Overall I found this paper to be thorough and well-written. I found the criteria and methods used to identify risk-based indicators to be scientifically defensible and I found the selected indicators and their prioritization appropriate in Endeavour Hydrothermal Vents MPA. The purpose of the paper was clearly stated, as was the context of this paper within the EHV MPA conservation objective process. Together with the appendices, the working paper provided enough detail to properly evaluate the conclusions. Also, the advice to decision-makers was clear, concise, and reflected uncertainties in the data.

Congratulations!

Here are my specific comments/suggestions:

Section 2.1: Description of EHV MPA needs a bit more detail with respect to hydrothermal vent basics for context.

Section 3.2: "These attributes are linked directly from the terms of resilience from the ERAF, where acute change and chronic change correspond to population size and condition, respectively." Not sure I understand or agree with this. Can't population size be chronic and population condition be acute as well? Did the output of the ERAF link these, specifically, or were these assumptions you made in the ERAF? I agree that you should capture acute and chronic change, but don't necessarily agree that you're achieving that by looking at population size and condition for those two variables, respectively.

Appendix A: It would be helpful to have the complete list of all SEC criteria in a table at the beginning of the Appendix before you start listing which SEC criteria each SEC fulfills in the Appendix A Table. See comments in Section 5.3.2 and Appendix A.

Appendix C: One of the proposed indicators you list for population condition is "Community species richness and diversity". These community measures aren't used on populations, so I would suggest nesting them under a separate "Community Condition" heading in the tables.

Appendix F: Would add "Size (area) of sampling scar" to Sampling-Removal of Organisms-Areal coverage of removed organisms

Mining: Mining has become a real concern over the last few years. Below is a comment from Verena Tunnicliffe copied from her review (Feb. 13, 2015) of the hydrothermal vents section of Ban et al. 2015. Identification of Ecologically and Biologically Significant Areas (EBSAs) in Canada's Offshore Pacific Bioregion. This is definitely worth mentioning somewhere in the paper for potential stressors:

> *"Mining is a huge endeavour now with the deep-sea research biology community watching closely. The ISA has now granted prospecting licences in several international areas and there are leases granted for exploration in numerous countries. Actual exploitation agreements exist with Nautilus Minerals in PNG – they will start mining vents next year. This issue is a very big one. To revise this paragraph, start with Boschen 2013. There are meetings worldwide to address*

approaches to deep-sea mining with PMS deposits leading the concerns. I have particular interest because I believe the Explorer-Juan de Fuca sites are extremely valuable as models for the deposits of interest. Teck Cominco toyed with Middle Valley as a target but the metals market is not there for this grade of deposit."

Written Review #3

Date: May 19, 2015

Reviewer: Rosaline Canessa, Coastal and Oceans Resources Analysis Group, Department of Geography, University of Victoria.

Working Paper: Thornborough, K., Dunham, J., and O, M. Development of risk-based indicators for SGaan Kinghlas-Bowie Seamount Marine Protected Area. CSAP Working Paper 2014OCN05.

1. Are the criteria and methods used to identify risk-based indicators scientifically defensible?

   Overall, the criteria and methods to identify indicators for SK-B are thorough, comprehensive and well supported. The risk-based approach is an appropriate alternative to ecological indicators given both the lack of data and specific conservation objectives for the SK-B MPA.

   The primary criteria to identify indicators, namely, theoretically sound, measurable/feasible, sensitive and historical data, are derived from literature with an assessment of what is relevant to SK-B. Sablefish could be argued as a species that is of interest to the public with respect to allowing commercial fisheries in an MPA, and should be considered in the Public Awareness category. The robustness of the methods is supported by building on results of EFRAF and relevant literature and the detailed material provided in the appendices.

2. Are the selected indicators and their prioritization appropriate in SGann Kinghlas-Bowie Seamount MPA?

   The proposed indicators are appropriate and amply supported in the detailed material provided in the appendices. With respect to noise disturbance sound frequency should be included as a stressor indicator, as this will vary by species. One concern I had was the creation of 3 bins for risk and uncertainty by dividing by the score range by 3. However, it was subsequently stated that the "division of scores was confirmed to be aligned with the natural division of the data". Evidence of this could be included in the appendices.

   Page 14 indicates a total of 196 SEC-stressor interactions. However, page 18 suggests 214 SEC-stressor interactions (74 potential and 140 current).

   With respect to determining whether population size, population condition or both was the most appropriate for each condition, how "similar" each score needs to be to include both needs to be clarified.

3. Other comments

   Additional areas of research to enhance the selection of indicators include:

   - Behavioural response of fish and invertebrates to noise
   - Research on indicators and monitoring at other seamounts or remote MPAs would be beneficial.

   The working paper critically emphasises two key relevant recommendations to managers: the need for baseline data for effective monitoring of ecosystem components in general and

to assess anthropogenic impact from; and the need for detailed conservation objectives to focus the relevancy of indicators and against which to evaluate the effectiveness of the MPA. These two recommendations cannot be understated.

With respect to the presentation of advice to decision makers, recommendations could be more direct and explicit. For example,

- In Section 6, conclusions should be distinguished from recommendations to decision makers.
- The scope and detail of recommendations to decision makers and MPA managers could be guided by a discussion with decision makers and MPA managers to ensure that the recommendations would be most useful.
- Examples of indicators that could be measured visually should be identified in Section 6
- Examples of indicators that could be measured or sampled during the same operations period could be identified in Section 6.
- Recommendations on which indicators are most important should be included.

Finally, in terms of readability, the report is repetitive in places and could be edited to reduce redundancy and correct several incomplete sentences.

APPENDIX F: SUGGESTED WORKING PAPER REVISIONS

Editor: Evelyn Chen

Adding clarification into the appendix about the refinement process (from Russ Jones question about how the refinement process worked)

Mention the new sponge species for future work considerations

EHV paper reviewer –Candice St. Germain

Her proposed edits are in her powerpoint presentation.

- EHV MPA description needs more detail w/ respect to hydrothermal vent basics for context.
- Appendix A: complete list of all SEC criteria in a table at the beginning of the Appendix
- Appendix C: separate Community condition heading for community species richness and diversity
- Appendix F: add "size(area) of sampling scar" to sampling-removal of organisms-areal coverage of removed organisms
- mention "mining" for potential stressors
- Q: population size always acute and condition always chronic? yes–defined in the ERAF (Emily)

EHV paper reviewer –Sean MacConnachie

His proposed edits are in his Written Review document (mostly editorial).

- More emphasis about prioritization based on SEC-Stressor interaction.
- Authors agree that there is lots of redundancy, would like a discussion about what should be cut, etc.
- There was discussion about keeping the genetics indicator information. Important to know about genetic diversity for long term, and it can be done readily. Useful for managers to have a longer list and keep the genetic indicator on the list.

SKB paper reviewer –Rosaline Canessa

- Noise frequency should be included as a stressor indicator (species dependent)
- Check consistency of the number of total SEC-stressor interactions (pg14 and 18)
- Clarification on population size and population conditions.. (only when there was a score of 0 was it not included)
- Distinguish recommendations and conclusions for decision makers
- Identify examples of indicators that can be visually measured
- To stress the need for baseline data and more detailed conservational objectives
- Fish behavioral response as an additional research area

The authors largely agreed with these edits.

Public Awareness selection criterion should be consider with respect to Sablefish. The authors noted that they did not use it because they didn't want to distract from ecologically significant components

The authors pointed out evidence consistent with the statement that the "division of scores was confirmed to be aligned with the natural division of the data": this evidence is in color coded tables in appendix showing high moderate and low.

Identification of Methodology Issues for Discussion

- It was noted that all potential SECs at the EHV MPA were not included in Appendix D, particularly a relatively newly identified endemic snail (the same issue may be applicable to the SKB document). The authors noted that they could highlight the snail species endemic to EHV in recommendations for future work, but couldn't be included in the process this time because the SEC list was derived from an earlier process.
- There was a suggestion to consider size structure as an indicator in addition to biomass. It was noted by the authors that size structure should be included, some SECs might be able to be measured by visual techniques, but some might need to be sampled destructively. Biomass sometimes doesn't tell you the whole story, for example, a few of large animals vs lots of small animals may have the same estimated biomass but tell the biologist different things about the population. It was noted that size structure tells you about recruits in a population.
- It was recommended that the management of sampling activities in the MPAs be improved. For example, managers should work with researchers to become more strategic and tactical in sampling rare and limited species. A meta-database would be useful to determine if certain sampling activities have already been conducted, etc.
- A change was suggested to clarify the "genetics" indicator (genetic diversity, measurable components might be allele frequencies, number of haplotypes (polymorphism)
- 1.3- 'Count per unit area or distance from venting' instead of 'average count'
- 1.4- Functional index to be considered (such as average trophic level, etc.)
- 1.5- Active vs inactive chimney- really good indicator of overall venting output
- 1.5- have a record of the equipment locations through time
- 1.6- population condition- can look for the extent of microbial mats (ex. bright orange mats means iron...)
- Definitions (for introduction section?) of different types of environments present at EHV (for diffuse venting, etc.)
- Have the Appendix C (summary table of proposed sec indicators) in the main document instead of the Appendix (?)

Appendix D for SKB:

- 1.2- Size structure as alternative to biomass
- 1.3- spatial distribution in the MPA, instead of "range of species"
- 1.4- CPUE instead of biomass for Sablefish/Rougheye Rockfish, for example?
- 1.4- for "genetics": "allele frequencies" instead

- Distribution of fish as an indicator – meaning spatial distribution within MPA. Species home range relevant to MPA size in some cases.
- Size frequency distribution as a measure of population condition

Indicator Selection Criteria:

- Keep theoretically sound criterion
- Keep differentiation between measureable and feasible: something can be measureable but not feasible (due to remoteness, etc.)
- Public awareness criterion is not really a pathway for "filtering", can still be left out (reworded for relevancy to this process)

Redundancies with ERAF:

- Compact the ecosystem indicators paragraph- make reference to ecosystem indicators, and a few examples to distinguish them between risk-based indicators, and say it is out of scope.
- 1.2- indicators can be taken out?
- Appendices H and I can be taken out?
- 5.3.2- take out section about the hydrothermal plume justifications
- Bowie WP Table 4.2- color code (or mark) stressors scored as potential vs current
- Present tables, etc. that were from other papers in the appendices? (or cite?)
- Alphabetize Table 1.7 in Appendix E in both WPs

Ecosystem Indicators:

- Recommendation to use the presented information to form operational objectives to manage human impacts on the MPAs..

Baseline data collection:

- Issue: make sure old data doesn't get lost, and maybe see if it can be used to establish baselines, make data available/catalogue

Indicator Thresholds:

- Associated with operational objections usually, but also with "tipping points" associated with some human judgment value (ex. don't want to see the system at a certain point)
- Comment that thresholds are out of this project's scope, and the need for operational objectives

Monitoring:

- Different monitoring strategies for potential vs current stressors.
- Tables and results – present current snapshot first, then potential.
- Potential sources for baseline data: SKB- from ~1990s, EHV- ~1980s?

Results and conclusions- SKB

Info gaps and approaches to address them:

- Should go back to past data and analyze them (biological, oceanographic and human activity data). Also, need for monitoring going forward.
- Propose experiment for unfished vs fished areas to study succession, etc. (Bowie vs other two seamounts)
- Update interim management measures in the WP

Results and conclusions- EHV

Indicator selections/prioritization rankings:

- To fix: SEC's weren't grouped by similar life history traits (about Table 1. In SAR)
- Is "areal coverage of removed organisms" appropriate?
- Is "proportion % of the area crushed" appropriate?
- Alteration of fluid flow (lots of organisms may be affected) may be an indicator for chimneys?- to include in future work considerations
- Two of the heavily sampled vent fields can be compared with the other two less sampled sites (control sites)

Measurement protocols:

- Sampling over vent fields may be considered (but want to leave it open for other options), most life in EHV focused around the venting fields

Info gaps and approaches to address them:

- Some points from SKB (above) also applicable
- Understanding overall natural variability as a system (changes in community development with time, management has to be able to differentiate between natural stressors and anthropogenic stressors- at the chimney level as well as field level)
- More detailed conservation objectives- to mention in SAR (especially because high endemism at the site?)

Additional Suggestions:

- More justification/explanation for the selection(?) criteria that were left out, but where they may be used in the future–for both SKB and EHV
- Measureable subcomponent for genetics indicator- instead of just "allele frequencies", add more wording like "polymorphism"
- Functional index- not to develop specific indices but to point to its direction, with maybe an example
- Some tables have current and potential stressors in different orders, maybe go back and look through if they were prioritized? or should be changed to be in consistent order.